CLAIMS

1. A method of manufacturing a tubular carbon molecule comprising:

a catalyst arranging step of arranging a metal having a catalyst function for a tubular carbon molecule through the use of melting by a modulated heat distribution; and

a growing step of growing a tubular carbon molecule.

2. A method of manufacturing a tubular carbon molecule according to claim 1, wherein

the heat distribution is applied through diffracting an energy beam in a one-dimensional direction or a two-dimensional direction.

3. A method of manufacturing a tubular carbon molecule according to claim 1 further comprising:

a height equalizing step of forming a tip of the tubular carbon molecule in a predetermined plane, and forming the tip into an open tip.

4. A method of manufacturing a tubular carbon molecule according to claim 3, wherein

in the height equalizing step, after a fixing layer is formed at least around the tubular carbon molecule to fix the tubular carbon

molecule, polishing on the tubular carbon molecule together with the fixing layer is carried out.

5. A method of manufacturing a tubular carbon molecule according to claim 4, wherein

the polishing is carried out by chemical mechanical polishing.

6. A method of manufacturing a tubular carbon molecule according to claim 1, wherein

in the growing step, a desired material is included in a tip of the tubular carbon molecule.

7. A method of manufacturing a tubular carbon molecule according to claim 6, wherein

the desired material is made of a dielectric material or a conductive material.

8. A method of manufacturing a tubular carbon molecule according to claim 6, wherein

the desired material is made of a metal having a catalyst function.

9. A method of manufacturing a tubular carbon molecule according to claim 3, further comprising:

an inserting step of inserting a magnetic material in at least tip portions of a plurality of tubular carbon molecules from open tips of the plurality of tubular carbon molecules.

10. A method of manufacturing a tubular carbon molecule according to claim 9, wherein

in the height equalizing step, after a fixing layer is formed at least around the tubular carbon molecules to fix the tubular carbon molecules, polishing on the tubular carbon molecules together with the fixing layer is carried out, and

in the inserting step, after a thin film made of the magnetic material is formed on the fixing layer so as to block the open tips, polishing on the thin film is carried out.

11. A method of manufacturing a tubular carbon molecule according to claim 10, wherein

the polishing is carried out by chemical mechanical polishing.

12. A method of manufacturing a tubular carbon molecule according to claim 1, wherein

the catalyst arranging step includes:

a melting step of applying a modulated heat distribution to a surface of a material substrate including a second material as an addtive in a first material so as to melt the surface of the material

substrate; and

a depositing step of depositing the second material in a position corresponding to the heat distribution through dissipating the heat of the surface of the material substrate.

13. A method of manufacturing a tubular carbon molecule according to claim 12, wherein

the second material is a material which lowers the melting point of the first material by adding the second material to the first material.

14. A method of manufacturing a tubular carbon molecule according to claim 12, wherein

in the depositing step, the second material is deposited on the surface of the material substrate in a planar shape through dissipating the heat of the surface of the material substrate.

15. A method of manufacturing a tubular carbon molecule according to claim 12, wherein

in the depositing step, a projection is formed on the surface of the material substrate through dissipating the heat of the surface of the material substrate, and the second material is deposited on at least a tip portion of the projection.

16. A method of manufacturing a tubular carbon molecule according to claim 12, wherein

the first material is a semiconductor or a metal, and the second material is a metal having a catalyst function.

17. A method of manufacturing a tubular carbon molecule according to claim 1, wherein

the catalyst arranging step includes:

a melting step of applying a heat distribution modulated according to a desired pattern to a surface of a material substrate so as to melt the surface of the material substrate;

a master forming step of forming a projection in which at least a tip portion thereof is made of a transfer material in a position corresponding to the heat distribution on the material substrate through dissipating the heat of the surface of the material substrate so as to form a master for transfer having a pattern of the projection on a surface thereof; and

a transferring step of forming a substrate through transferring the pattern of the master for transfer to a substrate to be transferred, and

the tubular carbon molecule is grown on the substrate.

18. A method of manufacturing a tubular carbon molecule according to claim 17, wherein

in the transferring step, a relative position between the master for transfer and the substrate to be transferred is shifted to transfer the pattern of the master for transfer to the substrate to be transferred a plurality of times.

19. A method of manufacturing a tubular carbon molecule according to claim 17, wherein

a heating process is carried out in the transferring step.

20. A method of manufacturing a tubular carbon molecule according to claim 1, wherein

the catalyst arranging step includes:

a melting step of applying a heat distribution modulated according to a desired pattern to a surface of a material substrate so as to melt the surface of the material substrate;

a projection forming step of forming a projection of a pattern in a position corresponding to the heat distribution through dissipating the heat of the surface of the material substrate; and

an adhering step of adhering a catalyst metal to a tip portion of the projection through pushing a metal substrate made of a metal having a catalyst function for a tubular carbon molecule to the projection.

21. A method of manufacturing a tubular carbon molecule

according to claim 1, wherein

the catalyst arranging step includes:

a melting step of applying a heat distribution modulated according to a desired pattern to a surface of a material substrate so as to melt the surface of the material substrate;

a projection forming step of forming the pattern of a projection in a position corresponding to the heat distribution through dissipating the heat of the surface of the material substrate; and

a planarizing step of planarizing the top surface of the projection.

22. A method of manufacturing a tubular carbon molecule according to claim 21, further comprising:

a top surface transferring step of transferring the planarized top surface of the projection to a substrate to be transferred.

23. A method of manufacturing a tubular carbon molecule according to claim 1, wherein

the catalyst arranging step includes:

a melting step of applying a heat distribution modulated according to a desired pattern to a surface of a material substrate so as to melt the surface of the material substrate;

a projection forming step of forming the pattern of a projection in a position corresponding to the heat distribution through

dissipating the surface of the material substrate; and

a control layer forming step of forming a control layer which retards the growth of a tubular carbon molecule on a surface of the projection except for an extreme tip portion.

24. A tubular carbon molecule, being formed through arranging a metal having a catalyst function for a tubular carbon molecule through the use of melting by a modulated heat distribution and growing a tubular carbon molecule through the use of the metal having the catalyst function.

25. A method of manufacturing a recording apparatus, comprising:

a catalyst arranging step of arranging a metal having a catalyst function for a tubular carbon molecule through the use of melting by a modulated heat distribution;

a growing step of growing a tubular carbon molecule;

a height equalizing step of forming a tip of the tubular carbon molecule in a predetermined plane, and forming the tip into an open tip; and

an inserting step of inserting a magnetic material in at least a tip portion of the tubular carbon molecule from the open tip.

26. A method of manufacturing a recording apparatus

according to claim 25, wherein

in the height equalizing step, a fixing layer is formed at least around the tubular carbon molecule to fix the tubular carbon molecule, and polishing on the tubular carbon molecule together with the fixing layer is carried out, and

in the inserting step, a thin film made of the magnetic material is formed on the fixing layer so as to block the open tip, and polishing on the thin film is carried out.

27. A method of manufacturing a recording apparatus according to claim 26, wherein

the polishing is carried out by chemical mechanical polishing.

28. A method of manufacturing a field electron emission device, comprising:

a catalyst arranging step of arranging a metal having a catalyst function for a tubular carbon molecule on a substrate through the use of a modulated heat distribution; and

a cathode forming step of forming a cathode through growing a tubular carbon molecule.

29. A method of manufacturing a field electron emission device according to claim 28, wherein

in the cathode forming step, the substrate and an electrode

face each other, and an electric field is applied between the substrate and the electrode.

30. A method of manufacturing a field electron emission device according to claim 28, wherein

the substrate has a planar pattern made of the metal.

31. A method of manufacturing a field electron emission device according to claim 28, wherein

the substrate has a pattern of a projection in which at least a tip portion thereof is made of the metal.

32. A method of manufacturing a field electron emission device according to claim 31, wherein

in the cathode forming step, two of the substrates are disposed so that the patterns of the projection face each other, and an electric field is applied between the two substrates.

33. A method of manufacturing a field electron emission device according to claim 29, wherein

as the electrode, an electrode on which a pattern of a projection corresponding to the pattern of the substrate is formed is used, and the pattern of the substrate and the pattern of the projection of the electrode face each other.

34. A method of manufacturing a field electron emission device according to claim 28, wherein

the metal is arranged with a spacing of 100 nm or less.

35. A method of manufacturing a field electron emission device according to claim 28, wherein

the metal is arranged with a spacing of 50 nm or less.

36. A method of manufacturing a field electron emission device according to claim 28, wherein

the catalyst arranging step includes:

a projection electrode forming step of forming a pattern of a projection on a surface of a flat electrode through the use of a heat distribution modulated according to a desired pattern so as to form a projection electrode; and

a reducing/depositing step of forming a pattern which is made of a metal having a catalyst function and corresponds the projection electrode on the substrate through applying an electric field between the projection electrode and a conductive substrate in a catalyst solution including a metal having a catalyst function to reduce and deposit the metal.

37. A method of manufacturing a field electron emission

device according to claim 28, further comprising:

a separation groove forming step of forming a separation groove on a surface of the substrate so as to avoid the metal.

38. A method of manufacturing a field electron emission device according to claim 37, wherein

the separation groove is formed by irradiation with an energy beam.

39. A method of manufacturing a field electron emission device according to claim 37, wherein

the separation groove is formed through diffracting an energy beam in a one-dimensional direction or a two-dimensional direction.

40. A method of manufacturing a field electron emission device according to claim 37, wherein

the separation groove is formed in a parallel line or a grid.

41. A method of manufacturing a field emission device according to claim 28 further comprising:

an extraction electrode forming step of forming an extraction electrode corresponding to the cathode.

42. A method of manufacturing a field electron emission

device according to claim 41, wherein

the extraction electrode forming step is carried out between the catalyst arranging step and the cathode forming step.

43. A method of manufacturing a field electron emission device according to claim 41, wherein

the extraction electrode forming step includes:

an insulating film forming step of forming an insulating film on the substrate;

a conductive film forming step of forming a conductive film on the insulating film; and

an aperture portion forming step of forming an aperture portion in the insulating film and the conductive film corresponding to the cathode.

44. A method of manufacturing a filed electron emission device according to claim 28 further comprising:

a height equalizing step of forming a tip of the tubular carbon molecule in a predetermined plane, and forming the tip into an open tip.

45. A method of manufacturing a field electron emission device according to claim 44, wherein

in the height equalizing step, after a fixing layer is formed at

least around the tubular carbon molecule to fix the tubular carbon molecule, polishing on the tubular carbon molecule together with the fixing layer is carried out.

46. A method of manufacturing a field electron emission device according to claim 45, wherein

the polishing is carried out by chemical mechanical polishing.

47. A field electron emission device, comprising:

a cathode which includes a tubular carbon molecule grown through the use of a metal having a catalyst function for a tubular carbon molecule arranged on a substrate through the use of melting by a modulated heat distribution.

48. A method of manufacturing a display unit, the display unit including a field electron emission device and a light emitting portion which emits light according to collision of electrons emitted from the field electron emission device,

wherein a step of forming the field electron emission device includes:

a catalyst arranging step of arranging a metal having a catalyst function for a tubular carbon molecule on a substrate through the use of melting by a modulated heat distribution; and

a cathode forming step of forming a cathode through growing a

tubular carbon molecule.

49. A display unit, comprising:

a field electron emission device; and

a light emitting portion which emits light according to collision of electrons emitted from the field electron emission device,

wherein the field electron emission device includes a cathode which includes a tubular carbon molecule grown through the use of a metal having a catalyst function for a tubular carbon molecule arranged on a substrate through the use of melting by a modulated heat distribution.